

## MOBILE TERMINAL EQUIPMENT AND ANTENNA THEREOF

### Technical Field

The present invention relates to a mobile terminal  
5 that is adaptive for preventing an antenna radiation  
pattern from being distorted regardless of the length of  
the mobile terminal, and an antenna thereof.

### 10 Background Art

In a wireless communication network such as a mobile  
network or a wireless local loop WLL, a base station is  
installed between a mobile switching center and a mobile  
15 terminal of a subscriber, and a wireless signal is  
exchanged between the base station and the mobile terminal  
of the subscriber. An antenna is installed in the mobile  
terminal and the base station for transmitting/receiving  
the wireless signal.

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The antenna of the mobile terminal, as shown in FIG. 1,  
is conventionally composed in a method where a high  
frequency signal source 13 is connected between a monopole

antenna 12 and a grounded terminal body 11. The monopole antenna 12 applied to the mobile terminal is classified into a whip antenna and a helical antenna.

5       A whip antenna 15, as in FIG. 2, is designed to have a length of  $\lambda/4$  in order to maximize its transmission/reception efficiency, if a frequency wavelength is  $\lambda$ . And, the helical antenna 16 has its length of  $\lambda/4$  in relation to an electric wave and is  
10       designed to be twisted in a screw shape in order to shorten the length. The whip antenna 15 has a higher gain than the helical antenna 16, but is designed to be extended because of the appearance due to the length, and designed to be jointly used together with the helical antenna 16. The  
15       helical antenna 16 is inserted into and fixed in a housing 14 that is installed at one side of the upper end of the terminal body 11.

      In case that the ground-plane of the monopole antenna  
20       12 is a perfect ground-plane, an image is displayed in a grounding opposite direction. The antenna of the mobile terminal is operated like a dipole antenna by the image displayed in the grounding opposite direction and the monopole antenna 12. However, the ground-plane of the  
25       mobile terminal is conventionally not formed ideally, thus

the ground-plane affects the performance of the antenna of the mobile terminal.

The influence that is caused to the antenna by the ground-plane becomes different in accordance with the length of the mobile terminal. The antenna of the mobile terminal is operated at a maximum performance, when the length L1 of the monopole antenna 12 is  $\lambda/4$  and the length L2 of the terminal body 11 is  $\lambda/4$ , as in FIG 1.

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The body length L2 of the mobile terminal is conventionally is designed to be  $\lambda/4$  of the wavelength which is used in a cellular method. Accordingly, the antenna of the mobile terminal operates with the best transmission/reception efficiency when it is operated on a cellular basis because the length of the mobile terminal body 11 is optimized to be  $\lambda/4$ . However, if the mobile terminal is used in a personal communication service PCS method, the wavelength of the electric wave corresponds to half the cellular method in the PCS of which the usage frequency is approximately two folds higher than the cellular method, thus the length of the mobile terminal body 11 is  $\lambda/2$ . Because of this, the current distributed in the mobile terminal body 11 becomes relatively larger than the current radiated in the monopole antenna 12. As a

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result, in the PCS, as in FIG. 3, an antenna radiation pattern 20 is tilted downward, i.e., toward the terminal body 11. Accordingly, if the mobile terminal designed on the basis of the cellular method is applied to the PCS method, the antenna radiation pattern 20 is reduced in the direction of  $-90^{\circ}$  to  $+90^{\circ}$  as in FIG. 3. This phenomenon acts as a cause that reduces the transmission /reception efficiency of the mobile terminal when considering that the base station antenna is located on the top of the terminal.

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#### **Disclosure of Invention**

Accordingly, it is an object of the present invention to provide a mobile terminal that is adaptive for preventing an antenna radiation pattern from being distorted in an upper part regardless of the length of the mobile terminal, and an antenna thereof.

It is another object of the present invention to provide a mobile terminal that is adaptive for increasing the transmission /reception efficiency of a mobile terminal, and an antenna thereof.

In order to achieve these and other objects of the

invention, a mobile terminal and an antenna thereof according to an aspect of the present invention includes a separate grounding means having a length of  $\lambda/4$  in relation to the waveform  $\lambda$  of an electric wave.

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### Brief Description of Drawings

These and other objects of the invention will be apparent from the following detailed description of the  
10 embodiments of the present invention with reference to the accompanying drawings, in which:

FIG. 1 is a diagram representing a conventional mobile terminal;

FIG. 2 is a sectional diagram representing a whip  
15 antenna and a helical antenna of FIG. 1 in detail;

FIG. 3 is a diagram representing a vertical radiation pattern of an antenna shown in FIG. 1;

FIG. 4 is a diagram representing a mobile terminal and an antenna thereof according to a first embodiment of the  
20 present invention;

FIG. 5 is a diagram representing a vertical radiation pattern of the antenna shown in FIG. 4;

FIG. 6 is a diagram representing a mobile terminal and an antenna thereof according to a second embodiment of the

present invention;

FIG. 7 is a diagram representing a mobile terminal and an antenna thereof according to a third embodiment of the present invention;

5        FIGS. 8 and 9 are diagrams representing a mobile terminal and an antenna thereof according to a fourth embodiment of the present invention;

FIG. 10 is a diagram representing a mobile terminal and an antenna thereof according to a fifth embodiment of  
10 the present invention; and

FIG. 11 is a diagram representing a vertical radiation pattern of the antenna shown in FIG. 10.

## 15    **Best Mode for Carrying out the Invention**

Reference will now be made in detail to the preferred embodiments of the present invention, examples of which are illustrated in the accompanying drawings.

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With reference to FIGS. 4 to 11, embodiments of the present invention will be explained as follows.

Referring to FIGS. 4 and 5, a mobile terminal  
25 according to a first embodiment of the present invention

includes a monopole antenna 32 installed at one side of an upper end of a terminal body 31, and a grounding wing 34 connected to a ground voltage source GND in the terminal body 31.

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A display means such as a liquid crystal display LCD and/or an electro-luminescence EL and an input means such as a key pad and a touch panel are installed in the terminal body 31. Further, a power circuit and a signal transmission/reception circuit inclusive of the display means, the input means and a high frequency signal source 43 are installed in the terminal body 31.

The monopole antenna 32 is inserted into a housing that is installed at one side of an upper end of the terminal body 31, and a high frequency signal power is supplied from a high frequency signal source 33. The high frequency signal source 33 is connected between the monopole antenna 32 and a ground voltage source. The length  $L_1$  of the monopole antenna 32 is  $\lambda/4$  in relation to the wavelength  $\lambda$  of an electric wave, and it can be realized in a helical antenna in order to reduce the physical length.

The grounding wing 34 is connected to the ground

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voltage source GND within the terminal body 31 to act as a grounding electrode of the antenna. The grounding wing 34 is manufactured of a flexible metal material or in a wire shape where a plurality of metal pieces are linked in a chain shape to have flexibility, and is connected to one side of the terminal body 31. The length  $L_3$  of the grounding wing 34 is  $\lambda/4$  in relation to the wavelength  $\lambda/4$  of an electric wave, and it can be different in accordance with the transmission /reception frequency of the electric wave and the shape of the mobile terminal.

Each length of the monopole antenna 32 and the grounding wing 34 is  $\lambda/4$  in relation to the length  $\lambda$  of an electric wave, thus it substantially operates in the same manner as the dipole antenna.

As a result of experimenting an antenna characteristic in a electric wave frequency range of PCS in relation to the mobile terminal as shown in FIG. 4, the antenna of the mobile terminal as in FIG. 5 does not have a null point in the radiation pattern in relation to the entire azimuth. According to this experiment, the distribution of the current flowing in the monopole antenna 32 and the distribution of the current flowing in the grounding opposite direction are made to be uniform by the grounding



wing 34, thus even though the mobile terminal is used in the PCS base, the antenna radiation pattern 40 is known to be relatively uniform in the entire azimuth. Accordingly, the mobile terminal as in FIG. 3 might be able to increase  
5 transmission/reception sensitivity in the entire azimuth even in any usage frequency regardless of the length of the mobile terminal.

FIG. 6 represents a mobile terminal and an antenna  
10 thereof according to a second embodiment of the present invention. In FIG. 6, for the same components as the mobile terminal shown in FIG. 5, the same reference numeral is given and the detail description thereof is omitted.

15 Referring to FIG. 6, the mobile terminal according to the second embodiment of the present invention includes a dielectric substance formed between the grounding wing 34 and the terminal body 31.

20 The dielectric substance 35 has a fixed dielectric constant, and plays a role of reducing a gap G1 between the terminal body 31 and the grounding wing 34 by increasing the degree of insulation between the terminal body 31 and the grounding wing 34. The higher the dielectric constant  
25 of the dielectric substance 35, the smaller the gap G1

between the terminal body 31 and the grounding wing 34. The dielectric constant of the dielectric substance 35 is desirable to be about 3~40.

5        On the other hand, the grounding wing 34 might be exposed to the outside of the terminal body 31 as in FIG. 4, but it might be formed within the terminal body 31 as FIG. 7.

10       Referring to FIG. 7, a mobile terminal according to a third embodiment of the present invention includes a grounding wing 37 that is embedded within the terminal body 31.

15       The grounding wing 37 is connected to a ground voltage source GND within the terminal body 31. The grounding wing 34 is formed as a metal thin film within a separate space 36 where there is no metal shield 35 for intercepting an electro magnetic interference EMI. A length L3 of the  
20       grounding wing 37 is  $\lambda/4$  in relation to the waveform  $\lambda$  of an electric wave, and it can be different in accordance with the transmission/reception frequency of an electric wave and the shape of the mobile terminal.

25       An EMI intercepting metal shield 38 formed in the

inner surface of the housing of the terminal body 31 is formed at a printed circuit board PCB part on which a high frequency signal source 33, a ground voltage source GND and various drive circuits are mounted, except for a separate  
5 space 36 where the grounding wing 37 is formed within the terminal body 31.

FIGs. 8 and 9 represent a mobile terminal and an antenna thereof according to a fourth embodiment of the  
10 present invention.

Referring to FIGs. 8 and 9, the antenna of the mobile terminal according to the fourth embodiment of the present invention includes an upper coil 72 wound in an upper core  
15 71, and a lower coil 75 wound in a lower core 74.

The twisted whole length of the upper coil 72 is  $\lambda/4$  in relation to the waveform  $\lambda$  of an electric wave, thus the upper coil 72 acts as a monopole antenna. The upper coil  
20 72 is connected to a conductive inner core 73 that penetrates the lower core 74, and it receives a high frequency signal power from a high frequency signal source 43 through the conductive inner core 73. The twisted whole length of the lower coil 75 is  $\lambda/4$  in relation to the  
25 waveform  $\lambda$  of an electric wave. The lower coil 75 is wound

on the surface of the lower core 74 insulated from the  
conductive inner core 73, and one end thereof is connected  
to the ground voltage source within the terminal body 41  
and the other end acts as a ground wire that is not  
5 connected to any power source.

The antenna 42 might increase the transmission  
/reception sensitivity of the antenna in relation to the  
entire azimuth even in any usage frequency environment  
10 regardless of the length of the terminal body 41 by the  
ground wire, i.e., the lower coil 75, having the length of  
 $\lambda/4$  in relation to the waveform  $\lambda$  of an electric wave.

FIG. 10 represents an antenna of a mobile terminal  
15 according to a fifth embodiment of the present invention.  
The antenna of FIG. 10 might be applied as the antenna of  
the mobile terminal of FIG. 8.

Referring to FIGs. 8 and 10, the antenna 42 of the  
20 mobile terminal affording to the fifth embodiment of the  
present invention includes an upper coil 82 receiving a  
high frequency signal power, and at least one lower coil 84,  
85 of which one side is grounded.

25 Further, the antenna 42 of the mobile terminal has a

conductive inner core 83 inserted and further includes a core 81 having a conductive surface. One end of the conductive inner core 83 is connected to one end of the upper coil 82, and the other end of the conductive inner core 83 is connected to a high frequency signal source 43. One end of the lower coils 84, 85 and the ground voltage source are connected to the surface of the core 81.

The twisted whole length of the upper coil 82 is  $\lambda/4$  in relation to the waveform  $\lambda$  of an electric wave, thus the upper coil 82 acts as a monopole antenna. The upper coil 82 receives a high frequency signal power from a high frequency signal source 43 through the conductive inner core 83. The twisted whole length of the lower coils 84, 85 is  $\lambda/4$  in relation to the waveform  $\lambda$  of an electric wave, and the lower coils 84, 85 act as a ground wire that is connected to the ground voltage source through the conductive surface of the core 81.

The antenna 42 might increase the transmission/reception sensitivity of the antenna in relation to the entire azimuth even in any usage frequency environment regardless of the length of the terminal body 41 by the ground wire, i.e., the lower coil 75, having the length of  $\lambda/4$  in relation to the waveform  $\lambda$  of an electric wave.

FIG. 11 applies the antenna 42 as in FIG. 10 in relation to the mobile terminal as in FIG. 8 and is an antenna radiation pattern obtained at the antenna's characteristic experiment in the electric wave frequency range of the PCS. According to the experiment result, as it can be known in FIG. 11, the antenna radiation pattern obtained in the antenna of FIG. 10 is shown to be equal to the antenna characteristic of the cellular range. That is, the antenna 42 as in FIG. 10 operates as an ideal dipole antenna characteristic even in the PCS base. Further, according to the result of measuring a receiving signal strength in relation to the mobile terminal to which the antenna 42 as in FIG. 10 is applied, a receiving gain is measured to be high. Particularly, as a result of experiment in a state that the mobile terminal is held by a hand and adhered closely to a head in the same manner as the real telephone conversation environment of the mobile terminal, the average receiving gain thereof is measured to be higher than the average of 5dB when compared with the mobile terminal other than the same kinds.

The mobile terminal and the antenna thereof according to the embodiment of the present invention might prevent the distortion of the antenna radiation pattern in any usage frequency environment regardless of the length of the

mobile terminal by use of the separate grounding means having the length of  $\lambda/4$  in relation to the waveform  $\lambda$  of the electric wave. Further, the mobile terminal and the antenna thereof according to the embodiment of the present invention might increase the transmission/reception efficiency of the mobile terminal by applying the grounding means to the mobile terminal

Although the present invention has been explained by the embodiments shown in the drawings described above, it should be understood to the ordinary skilled person in the art that the invention is not limited to the embodiments, but rather that various changes or modifications thereof are possible without departing from the spirit of the invention. Accordingly, the scope of the invention shall be determined only by the appended claims and their equivalents.